Collider-Accelerator Department
(C-AD)

RADIOBIOLOGY USER TRAINING

Radiation Safety
Conventional Safety
Access Control

INFORMATION GUIDE

August 2006

RADIOBIOLOGY USER TRAINING

This course is required if you want unescorted access into primary areas associated with Radiobiology or Physics experiments at the NASA Space Radiation Lab (NSRL) or the Alternating Gradient Synchrotron (AGS) facilities. Primary areas include target rooms and areas where the beam is fully enclosed in a tube-like enclosure (beam pipe). Primary areas are fully enclosed by shielding, fences or other barriers. These areas have interlocked access gates. It is required that you have facility-specific knowledge for entry.

A pre-requisite for this course is BNL Radiation Worker-1 (RW-1) training. The retrain period for RW-1 and C-AD Radiobiology User Training is two years.

You are also required to read and sign a work plan document for your specific experimental run. Information about the work plan document may be obtained from your Experiment Spokesperson or from the Collider-Accelerator Department (C-AD) Liaison Physicist for your experiment.

RW-1 and C-AD Radiobiology User Training are the minimum training requirements for unescorted access into the primary areas (including target areas), as well as for unescorted access to AGS Bldg 912, most of which is a posted Radiation Area. Other additional training may be required depending on your work activities. Examples of other training:

Lab Standard
Hazardous Waste Generator
Regulated Medical Waste Generator
Bloodborne Pathogens Awareness
Benchtop Dispersibles*
Radioactive Waste Generator
Cryogen Safety
Laser Safety
Compressed Gas

This course covers

- Physical design features and administrative controls that are used to prevent accidental radiation exposures in experimental areas.
- Conventional safety issues.
- * Certain learning objectives from BNL's Benchtop Dispersibles Training. You would also need to complete a Benchtop Dispersibles "Practical" to complete this qualification if you will be working with dispersibles. This qualification is valid for limited dispersibles work at NSRL only and NOT other BNL locations.

Your Experiment Spokesperson or Liaison Physicist is responsible for ensuring the collaboration is qualified in experiment-specific training.

Question: If a primary area is improperly entered; for example, by climbing over a shield block or by slipping through a hole in a gate, could you be killed by exposure to the beam?

Answer: Yes. The beam can be intense enough to deliver a lethal dose.

In addition to ionizing radiation hazards, primary areas and experimental areas at the C-AD complex may contain hazards posed by:

heavy objects
mechanical equipment
overhead cranes
heights
high magnetic fields
hot and cold surfaces
high-voltage and high-current electrical systems
high noise
radio frequency (RF) radiation
contamination
slips, trips, falls

USERS' CENTER

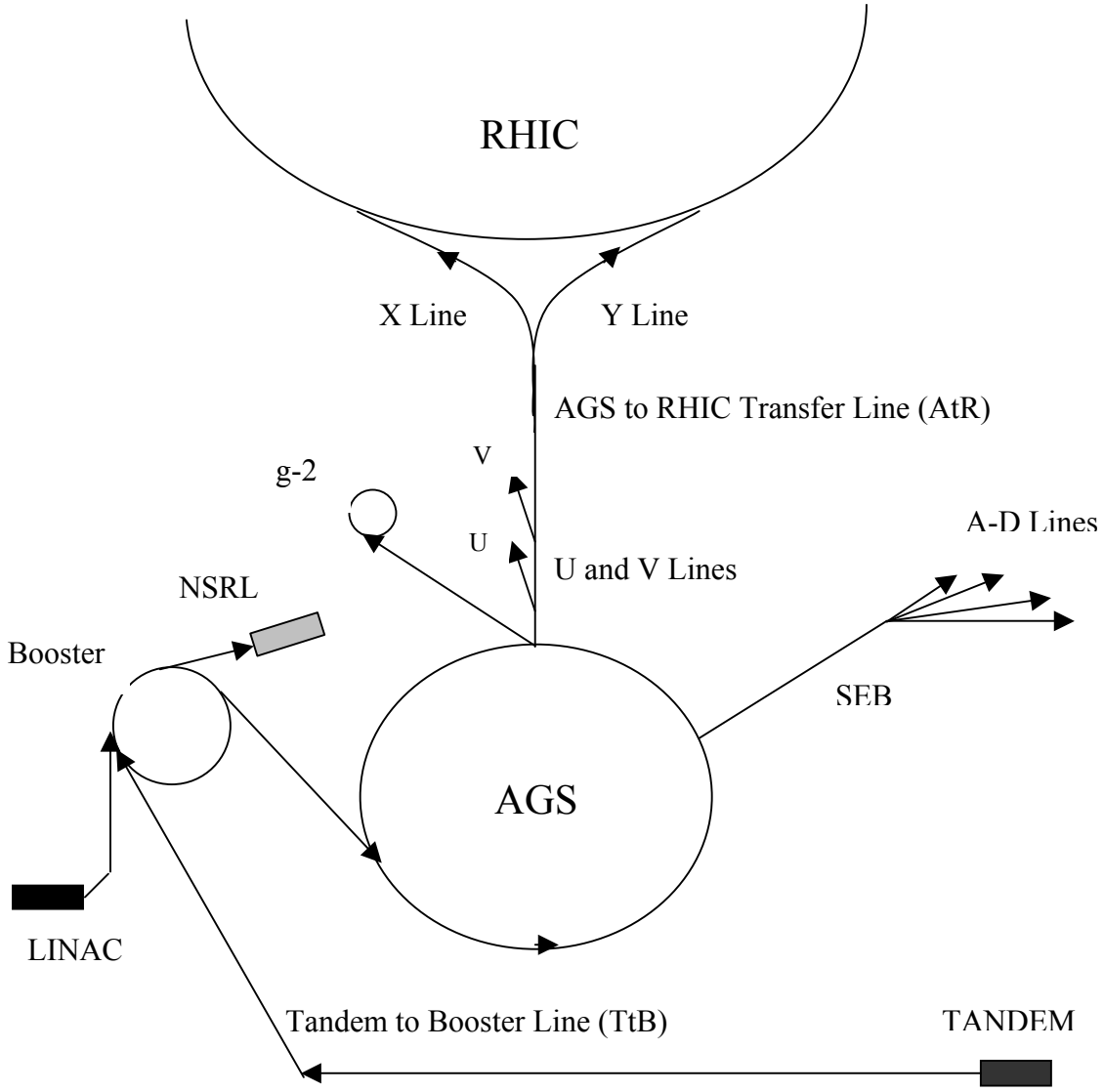
All users are required to check in and out at the BNL RHIC & AGS Users' Center. The Users' Center is located in building 355A, telephone 631-344-5975, or e-mail userscenter@bnl.gov. During the check-in process you will be familiarized with Brookhaven's commitments and obligations to its visiting population as well as BNL's expectations and requirements for individuals visiting the laboratory. The checking out process at BNL is very important. When you leave the laboratory, be sure to return any personal radiation monitoring devices (thermoluminescent dosimeter (TLD), self-reading dosimeter (SRD)), access cards and access keys.

LABORATORY COMPUTERS

Any User, BNL employee, visitor, guest or contractor who is given access to the BNL network and its computing resources must complete a BNL Course titled "Cyber Security". This is a web-based course that may be completed at the BNL RHIC & AGS Users' Center.

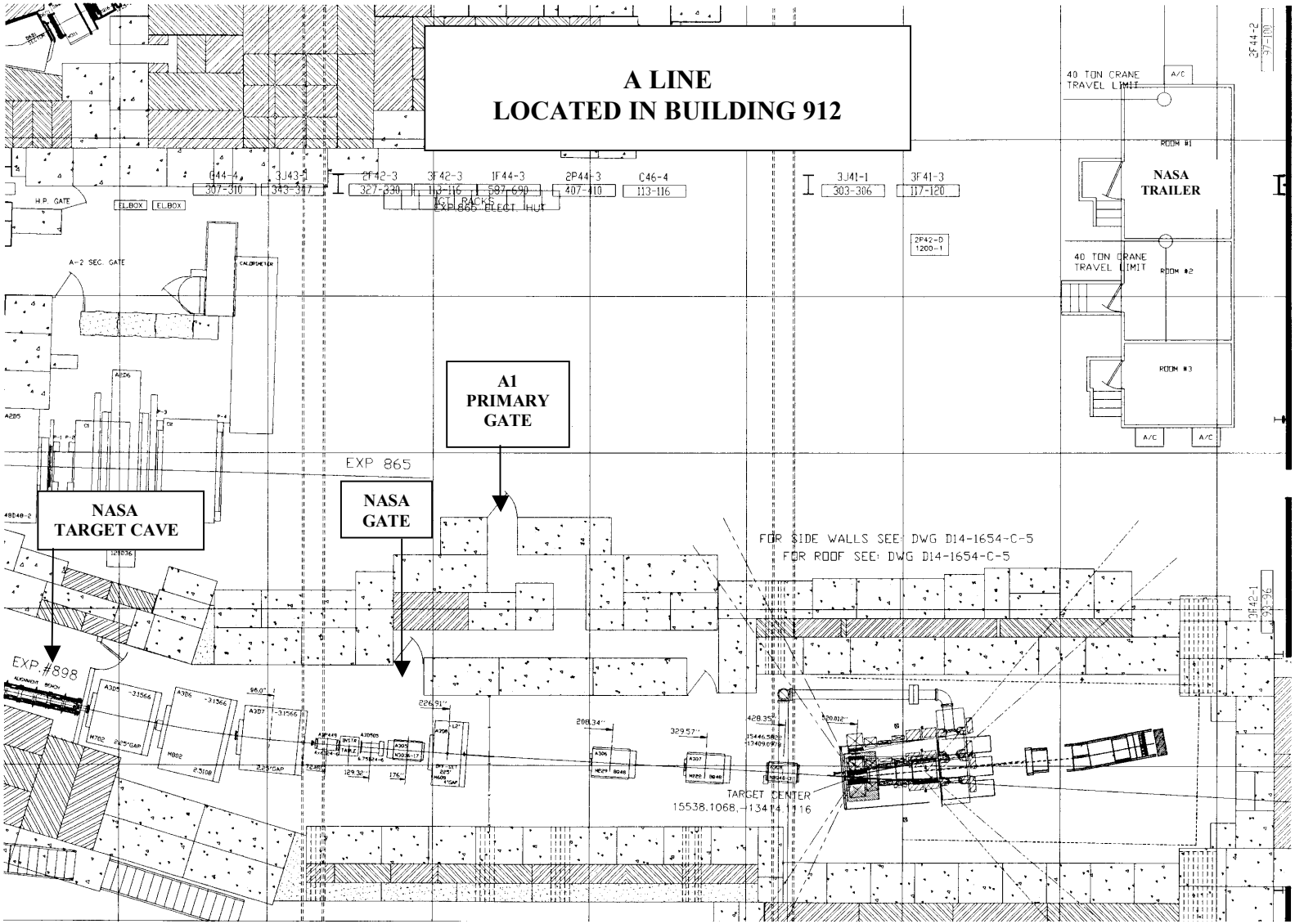
C-AD FACILITY DESCRIPTION

The Collider-Accelerator complex includes the Tandem Van De Graaff, Linear Accelerator (LINAC), Alternating Gradient Synchrotron (AGS), and Booster accelerator, which deliver particle beam to NSRL, the AGS slow extraction beam (SEB) lines (to target caves in Bldg 912), as well as other areas. Even if your experiment is not running, beam may be ON in other areas of the C-AD complex. Observe all posting and warnings at all times.

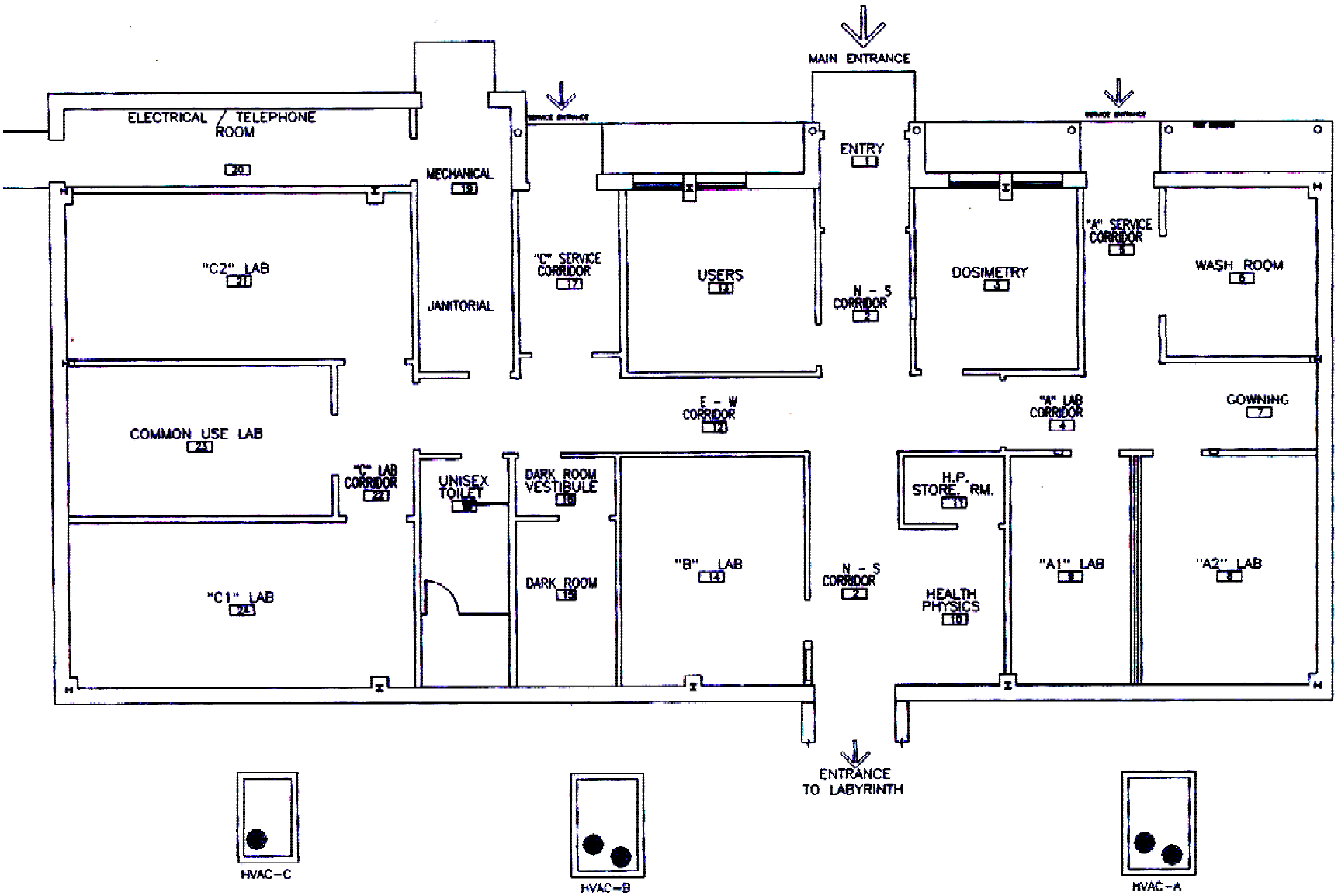


Views of experimental areas given on the following pages:

(A-Line and target cave in AGS Building 912)
(NASA Space Radiation Laboratory (NSRL) Support Building 958 with entrance to labyrinth to target room)


A LINE
LOCATED IN BUILDING 912
A1
PRIMARY
GATE
NASA
GATE
NASA
TARGET CAVE
NASA
TRAILER
40 TON CRANE
TRAVEL LIMIT
EXP 865
EXP #898
FOR SIDE WALLS SEE DWG D14-1654-C-5
FOR ROOF SEE DWG D14-1654-C-5
TARGET CENTER
15538.1068,-13474.1116

NASA Space Radiation Lab (NSRL) Support Bldg Floor Plan



RESEARCH SUPPORT SERVICES

A C-AD Liaison Physicist is assigned to your experiment. The Liaison Physicist is your primary contact for safety-related information associated with your experiment. Generally, the Liaison Physicist is responsible for a specific target station as well as the experiments. Your Liaison Physicist provides expert assistance in beam tuning during the first stage of a beam turn-on. He or she also optimizes the beam during sharing conditions. The C-AD Liaison Physicist should be consulted and should be considered your primary contact to help solve ionizing radiation problems, and to solve other problems of this general safety character.

A Liaison Engineer is also assigned to your experiment. The Liaison Engineer can arrange for such needs as rigging, surveys, safety reviews, electrical work, plumbing, carpentry and air conditioning. Items that require a safety review or other advance approvals are listed in C-AD Operations Procedure Manual (OPM) Chapter 9. The Liaison Engineer should be consulted regarding special requirements or modification of the experimental set-up. Your Liaison Engineer was the primary contact for the experimental team during the construction phase.

The Experiment Spokesperson for your experiment is the person who will act on behalf of all the collaborators on the experiment. His/her specific safety responsibilities are as follows:

- Experiment Spokespersons are responsible for ensuring that all personnel involved with the experiment apparatus are trained in the emergency procedures, and other safety-related procedures assigned by C-AD Safety Committees. These procedures may be associated with mixing flammable gases, moving protective shields into place or use of chemicals and controlled substances.
- The Experiment Spokesperson must inform the Liaison Physicist prior to the introduction of a new hazard. Sufficient time must be allowed for review of modifications prior to planned operations.
- Experiment Spokespersons are responsible for ensuring radioactive sources are inventoried and leak checked as required by C-AD and Federal Law. The C-AD Sealed Source Custodian must be notified prior to bringing a source to the C-AD experimental area.
- It is an Experiment Spokesperson's responsibility to ensure that all work by the collaboration is properly planned and reviewed for Environment, Safety & Health (ES&H) issues.

After the reviews by appropriate C-AD safety committees are completed, the Liaison Physicist, Liaison Engineer and the Experiment Spokesperson are made aware of safety requirements for your experiment. Either the Liaison Physicist, Liaison Engineer or the Experiment Spokesperson can provide safety information specific to your experiment, however, the **Liaison Physicist** should be considered your primary contact for this.

CONTACTS

This list may be placed near your telephone in the experimental area.

CONTACTS	EXT.
C-AD Liaison Physicist (Adam Rusek)	5830
C-AD Liaison Engineer (Dave Phillips)	4671
Experiment Spokesperson (Marcelo Vazquez)	3443
Experiment Spokesperson (Betsy Sutherland)	3380
Building Manager 912	2046
Building Manager 958	3072
C-AD ES&H Coordinator	4006
C-AD ESHQ Division Head	5272
C-AD Associate Chair for Safety	4250
C-AD Department Chair	4611
C-AD Environmental Coordinator	7520
ESD Environmental Compliance Representative	2905
C-AD Maintenance Coordinator	7205
C-AD CAS Watch	2024
Health Physics Office at C-AD	4660
C-AD Main Control Room	4662
C-AD Operations Coordinator	4662
C-AD Sealed Source Custodian	5636
C-AD Training Manager	7343
C-AD Training Office	7007

C-A ESHQ Division Web Site: http://www.rhichome.bnl.gov/AGS/Accel/SND/

C-AD CONDUCT OF OPERATIONS

Per agreement with the U.S. Department of Energy (DOE), the Collider-Accelerator Department (C-AD) is managed and operated under certain concepts that are part of what is know as Conduct of Operations. This agreement requires:

- Definitive lines of authority
- Written procedures for most operations
- Use of trained & qualified personnel where required
- Appropriate authorizations and work permits required before beginning a job or operations

During operating periods, responsibility for the safe and reliable operation of the C-AD complex resides with the on-duty Operations Coordinator (OC). The OC is the focal point for all questions or issues related to machine operations and can be reached at telephone extension 4662 in the C-AD Main Control Room (MCR), Bldg 911. The OC can make any necessary notifications and arrange for assistance when needed.

You can determine if the accelerators are in an operating or shutdown status by reading this information on TV monitors located throughout the C-AD complex. Also, control panels at access control gates to each experiment's target room will display a RED, YELLOW or GREEN light indicating an access control mode.

Access Control System

The Access Control System is a major design feature used for your protection. The Access Control System is designed to control access to primary areas. The target room at NSRL and the AGS slow extraction beam (SEB) target rooms are examples of primary areas. The system also detects excessive radiation levels outside primary/shielded areas via radiation monitors (called chipmunks). The system includes locked gates to primary areas throughout the C-AD complex. The gates control or limit access to the primary areas. When access is permitted, entry through the gates is with the use of a plastic card-key or a metal key.

Entries require **one card or key for one person only! Each person must enter with his or her own card or key.** More than one person entering under one card or key (without it being an approved escort) is considered a violation of procedure and is subject to disciplinary action.

There are 3 basic access control modes that the facility (or a particular gate) may be in. From most restrictive to least restrictive, ther are:

3 Modes:

ACCESS PROHIBITED Mode

CONTROLLED ACCESS Mode

RESTRICTED ACCESS Mode

Control Panels

Control panels are located at entrances and exits of access gates (or access doors). A system of lights on these panels indicates the access control mode:

Red Light	-	Access Prohibited
Yellow Light	-	Controlled Access
Green Light	-	Restricted Access

ACCESS PROHIBITED

In the Access Prohibited mode the machine is either operational (beam is ON) or beam is "ENABLED". With beam on, radiation levels within the primary areas are to be considered **lethal,** therefore NO ENTRY IS ALLOWED. Your plastic card key or metal Key Tree key will not work in this mode. If a gate is forced open, then at least two sensors will detect the door's open position and cause at least two critical devices (such as beam stops, steering magnets) to intercept the beam before a person can penetrate the area to any significant degree.

CONTROLLED ACCESS

In the Controlled Access mode, personnel are monitored (accounted-for) going in and out of the target area (primary area) by the Main Control Room (MCR). For entry, obtain a key from the key tree located at the access gate. In order to obtain a key from the key tree, you must first have your iris enrolled (both irises are typically enrolled). For iris enrollment, contact the C-AD Training Office at x7007, Bldg 911 Room A128. The minimum training requirements for access are BNL Radworker-1 (RW-1) Training and C-AD Radiobiology User Training (this training). During Controlled Access Mode, each individual entering the area is being accounted for; unlike during Restricted Access.

The procedure for entry into the NSRL target room during Controlled Access Mode is described below. The procedure for entry into the target room at the AGS SEB line is similar.

Under Controlled Access mode, many electrical systems associated with the accelerators are energized.

RESTRICTED ACCESS

For entry at NSRL, place your plastic card-key (orange card) on the card reader. The doors will open automatically. To exit, approach the doors; you will be sensed by a sensor and the doors will automatically open. Unless there is an emergency, do not manually open the doors.

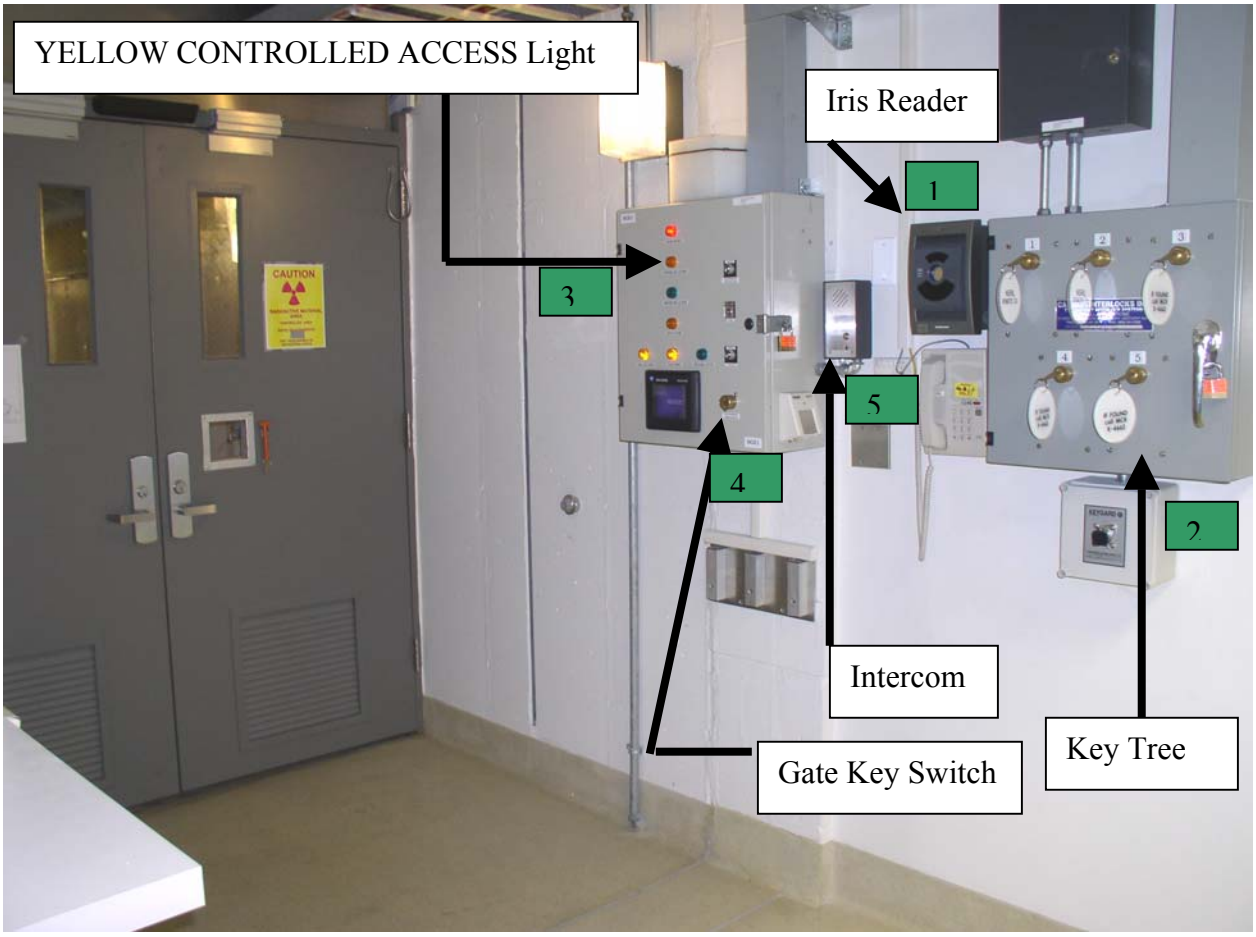
For entry to the AGS SEB line target room, a "256 Key" is used during Restricted Access.

Under Restricted Access mode, many electrical systems associated with the accelerators are de-energized and locked-out and tagged-out (LOTO'd). This pertains to beamline equipment not controlled by Users. Entry is not controlled by the MCR during Restricted Access. All whose training is current and are issued a key may enter and exit essentially at will. BNL Radiation Worker-1 and C-AD Radiobiology User Training are required for entry. During Restricted Access mode there is no beam. You are not being tracked going in or out of the area during this mode.

Question: What is the main purpose of the locked gates around the AGS and NSRL primary areas?

Answer: To protect persons from radiation hazards.

Entry Procedure for ***Controlled Access*** Mode at NSRL



1. Look into the iris reader with either eye (assuming both irises were registered) and center your eye in the box outline on the mirror.

Stand so that your eye is approximately 3 to 9 inches away.

Notes:	The iris reader will speak instruction back to you if you are too far or to close. You may adjust the tilt of the iris reader to suit your height.

2. **Place your right hand on the next sequential key available in the key tree.**

Note: The next available key must be removed.

When accepted, the iris reader voice will say "Identification Completed."

Remove the key from the key tree by turning the key counterclockwise and pulling.

Note: You have about 2 seconds to remove a key after being identified by the iris reader.

3. **Take the key to the adjacent control panel to the left of the iris reader.**

Observe that the *YELLOW* Controlled Access light is on; 2nd light from the top.

4. **Place the key in the gate key switch on the control panel.**

5. **Via the intercom, identify yourself to the MCR operator by giving your name and ask for a release (opening) of the door.**

Note: The intercom is usually turned on remotely by the MCR Operator, who is observing you remotely by camera.

6. **Turn the key (clockwise) with simultaneous release from MCR.**

Caution: The doors will open automatically towards you. Unless there is an emergency, do not manually open the doors.

7. **Remove the key and take it with you into the target room.**

8. **To leave the target room, use the intercom (or telephone) on the target room side of the doors and ask the operator for a release (opening) of the doors.**

> Note: The doors will open automatically (swinging away from you this time).

> **Caution**: Unless there is an emergency, do not manually open the doors. **In an emergency, open the doors manually using the crash bar and exit.**

9. **Return the key to any empty key switch in the key tree and lock in the key by turning it clockwise.**

> Note: Keys do not have to be returned to their original key switch location in the key tree; they can be returned to any empty

10. **Stand in front of the iris reader and center your eye in the box outline on the mirror. You are logged out when the camera voice says "Identification Completed."**

POWER FAILURE DURING ACCESS PROHIBITED MODE

During a power failure, the Access Control System may drop to Controlled or Restricted Access Mode if the battery back-up system also fails. Since there may be high levels of residual radiation in primary areas, DO NOT attempt to enter primary areas with your key immediately following a power failure. Contact the Main Control Room first to verify that it is safe to enter the area.

BEAM IMMINENT SIGNAL

Crash Buttons: (RED Button)

If the overhead lights go off or are dimmed while you are in a primary area at the AGS or at NSRL, push a crash button. The lights dimming or going off is the signal that BEAM IS IMMINENT!

If the lights go off or are dimmed, then do not assume it is a power failure; assume it is the beam -imminent signal.

Crash buttons are red and mushroom shaped. Access gates/doors have crash bars.

DO NOT PANIC, you have time; 30 seconds minimum.

Pushing crash buttons or opening access gates will turn lights on and will "crash" the beam (prevent beam).

One can always crash into or out of any primary area. Pressing crash buttons or opening access gates from the inside causes the beam stops to insert, lights to go on, and interrupts electrical power to the main magnet bus and RF devices. Crash buttons are located at several locations in the AGS beam line target room and in the NSRL target room. They are labeled with a red sign. After pushing a crash button or crash bar, call the MCR and notify them where you are located.

Question: If the lights go out or are dimmed in a primary area, should it be assumed that loss of electrical power has occurred?

Answer: No - - It should be assumed that the lights have gone out or were dimmed in order to signal that lethal hazards are imminent; that beam is imminent. You should press the nearest crash button to turn the lights on and disable beam, or exit through an access gate immediately.

Note: If you are near an exit gate, simply push open the gate using the crash bar on the gate and exit the area. You do not have to go search for a crash button. Exiting through a gate using the crash bar in Prohibited or Controlled Access mode will "CRASH" (prevent) the beam the same as pushing a crash button.

PERSONAL DOSIMETRY
(Thermoluminescent Dosimeter Badge - TLD)

The TLD **monitors** your exposure to beta, gamma, and neutron radiation. It offers **no protection** from radiation. TLDs are exchanged on a monthly basis. The TLD is the basis for the legal record of your occupational dose. Requirements for TLD use include:

- TLDs are worn when required by signs or postings, Radiological Work Permits, and when directed by Health Physics personnel. For example, the NSRL and the AGS beam line target rooms, as well as nearly all of Bldg 912, are areas requiring a TLD.
- TLDs must be worn on the front of the torso, between the waist and the neck unless directed otherwise by Health Physics personnel.
- The TLD should be returned to its assigned location at BNL when not in use.
- TLDs issued at BNL should not be worn at another facility and dosimetry issued from another facility should not be worn at BNL.
- Never wear another worker's TLD or allow someone else to wear your TLD.
- Trained personnel receive a TLD with a blue or yellow band on the front of the badge. The color alternates monthly. The exchange typically occurs at the beginning of each month. You must exchange your TLD for the "color-of-the-month" TLD if you are here through the exchange period.

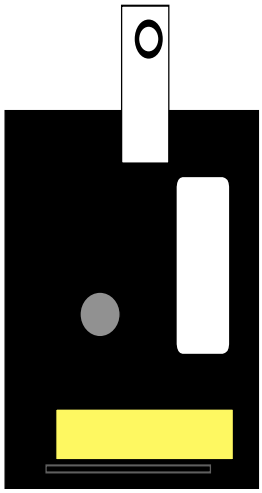
A red band on the front of the badge identifies an untrained visitor TLD. Individuals wearing a visitor TLD require an escort in areas posted and controlled to protect personnel from exposure to radiation and radioactive materials. If you encounter an unescorted visitor within a TLD area, immediately escort them out of the area. DO NOT remain in the area as their escort unless you have been properly approved to do so.

Return Red Visitor badges to the TLD badge board next to the C-AD Training Office* daily.
*(Bldg 911, Room A128)

Report any lost or damaged TLD immediately.

Note: "Health Physics" personnel is synonymous with "Facility Support" personnel at C-AD.

TLD Badge:



Lost or un-returned TLD badges

Please report a lost badge to the C-AD Training Office or the C-AD Health Physics Office. If a badge leaves the site inadvertently, please mail it back to the BNL Radiological Controls Division, Building 120, Upton, NY 11973.

Scenario:

Recently a lost badge belonging to a User who worked inside a secondary beam line had results as high as 7,000 mrem. Investigation concluded that the badge had fallen off the User's shirt and resided for several hours on top of a spectrometer magnet while the beam was 'on' but without any person present.

After the running period was over and the User left for his university, the badge results were reported to the C-A Department. The User later recalled that one day during the run, he found his TLD badge on top of a spectrometer magnet when he moved across it in order to reach his detectors. He put the badge back on and performed his work, not aware the badge had likely fallen off during a recent prior entry. He indicated his badge was likely to have been missing for only a few hours during his three-month stay at AGS.

If you think you may have lost your badge, even for a brief period, then please notify the HP Office (x4660) as soon as possible. Timely notification and the information you provide will help if we have to reconstruct events following an abnormal badge reading, although computer records of security system actions and area dose rates are also available to us.

During the past several years, the Laboratory has conducted several hundred investigations for un-returned badges. These investigations are costly. Although investigation costs have been substantially lower in more recent years, and we feel this is due to your cooperation, the cost could be reduced to zero. Please continue to leave badges at the assigned location at the end of your workday or shift. Do not take them outside the Laboratory. Most un-returned badges are the result of Users taking them off-site or not returning them at the conclusion of an experimental run. Your continued cooperation in eliminating this practice is appreciated.

WORK PLAN

Screening for Environment, Safety & Health (ES&H) Hazards

Experimental runs are screened for ES&H hazards. Users must **Read & Sign** a work plan document prepared for the specific experimental run. Information about the work plan document may be obtained from your:

- Experiment Spokesperson, or
- C-AD Liaison Physicist

A copy of the work plan document is usually located at the experimental area for you to read & sign.

Experiment Reviews -

All experiments and experimental support equipment must be reviewed by the C-AD Experimental Safety Review Committee (ESRC). It is extremely important that once approved, an experiment may not be changed or added to without re-review and approval. Contact your Liaison Physicist, Liaison Engineer, Experiment Spokesperson or the ESRC Chairperson if you have questions regarding this requirement.

Unplanned changes or additions may result in last minute delays for review and approval.

Any material placed in or near the primary beam needs to be reviewed by the ESRC and the ALARA Committees for gaseous or particulate releases that could contaminate the area, equipment or personnel, and must be reviewed for potential overheating.

CONTAMINATION

If you are not trained as a Contamination Worker you are not permitted unescorted access into areas that are posted "Contamination Area" or “Radiological Buffer Area". You may be escorted into these areas by a trained Contamination Worker under certain circumstances and with specific approvals, BUT not to do work. To *work* in these areas, the training and qualification is required. Upon exiting the area you are required to be “frisked” to check for contamination.

Dispersible or dispersed radioactive material may be a contamination concern. The following are examples of materials or activities that would be a radioactive contamination concern:

- Accidental spill of biological target material after irradiation
- Small pieces of broken beam line instrumentation
- The contents of fire extinguishers or gas cylinders that reside in primary areas during beam operations
- Leaking water from magnet cooling systems
- Drilling or grinding of materials in radiological areas

Working with Benchtop Dispersibles

Satisfactory completion of this course as well as an On-the-Job Training (OJT) demonstration with the Facility Support Representative will provide limited qualification to perform dispersibles work at NSRL. The dispersibles work will be conducted in properly posted areas under the control of a Job-Specific Radiological Work Permit (RWP) and Radiological Control Technician (RCT) coverage. The dispersible work is limited only to sample activity associated with beam irradiation. Dispersible work at NSRL with samples radio-labeled prior to irradiation requires the full BNL Benchtop/Dispersibles Course (RWT-500). This C-AD Radiobiology User Training and the follow-up NSRL demonstration training **does not** qualify you to work with dispersibles at any other facility at BNL.

Some contamination control work habits:

- Use of absorbent materials in hoods when working with liquids
- Holding absorbents under samples while transporting from primary area to work area
- Frequent surveys of work area
- Establish a small trash receptacle on the benchtop to minimize the transfer of contaminated materials across the work space
- Housekeeping: store excess materials outside of the work area

If you encounter contamination on skin or clothing > 100 counts per minute (cpm) above background on a GM "Frisker" , stop work and alert the RCT as soon as possible.

Animal Stays at NSRL

No animals can be removed from the Brookhaven Lab Animal Facility (BLAF) and maintained outside the BLAF (e.g.: at NSRL) for more than 24 hours (12 hours for USDA regulated species). *Requests for exceptions to this rule due to extenuating circumstances may be reviewed and approved by the BLAF Manager.* (Ref: Institutional Animal Care and Use Committee (IACUC) Dec 9, 2003 meeting minutes).

PRICE-ANDERSON AMENDMENTS ACT (PAAA)

It is important to make you aware of the absolute requirement to follow all radiological requirements at C-AD and BNL facilities. The Price-Anderson Amendments Act (PAAA) is a Congressional Act which provides the Federal Government the ability to impose enforcement penalties if you do not follow the requirements fully. If radiological requirements are violated, enforcement penalties may be imposed against Brookhaven Science Associates (BSA), or even against individuals. Personnel have been the subject of criminal investigations when found to willfully violate radiological requirements, such as removing a radiation barrier.

When signing documents related to radiation safety, an employee or User is essentially confirming that he or she will do his or her assigned work according to the rules. The signature does not mean that the individual is guaranteeing that the work will be carried out perfectly or that there is no potential for a violation. It does mean that the individual is performing his or her duties to the best of their ability and has made a good faith effort to comply with the radiation safety requirements. A "good faith effort to comply with the rules" means that the employee or User has familiarized him or her-self with the requirements that fall within his or her area of responsibility.

DOE has put nuclear and radiological safety requirements into the "Code of Federal Regulations" (CFR), Title 10 (Energy), Part 835. This is often referred to as: 10 CFR 835, Occupational Radiation Protection.

WARNING

It should be understood that any User who intentionally violates any radiological requirement, regardless of whether or not the User signs any document related to compliance, might be subject to criminal prosecution or other disciplinary action.

The intent of the Price-Anderson Amendments Act is to protect the health and safety of workers and the general public.

Eye Protection in NSRL Labs

Pay attention to postings to the entrances to the cell/animal labs at the NSRL facility. For example, entrances to the cell labs are typically posted as requiring eye protection when manipulating biological materials or chemicals.

GOLDEN RULES FOR RADIOLOGICAL AREAS

Do not climb over or defeat barriers
Do not ignore signs, labels, alarms or warning tags
If in doubt – Ask for help

Question: True or False? - The following may be ignored whenever you know the accelerators are off: fences, barriers, signs, warning tags and alarms in radiological areas.

Answer: False. The C-AD radiation protection program can only work if postings and barriers are obeyed at all times regardless of the status of the accelerators.

C-A EXPOSURE PHILOSOPHY

Radiation Exposure At DOE / C-AD Must:

Have A Net Benefit
Be As Low As Reasonably Achievable (ALARA)
Be Within Limits

Eating, drinking or smoking in a Controlled Area, Radiation Area or a High Radiation Area at C-AD is not permitted. Doing so would increase the time spent in the area and correspondingly the dose, without increasing the net benefit. Taking a shortcut through a radiological area in order to save time or to avoid inconvenience is not an appropriate practice.

ALARA STRATEGIES

"As Low As Reasonably Achievable"

Basic ALARA strategy on the part of the worker revolves around effective use of time, distance and shielding. Time tends to have a linear impact on dose reduction, distance a quadratic impact, and shielding an exponential impact. ALARA may also be incorporated into design and operations. The following are examples of ALARA at C-AD that you may incorporate into your work:

Use temporary shielding
Hold discussions in areas where the radiation level is the lowest
Use remote handling equipment
Plan the work and practice it outside a radiological area
Install quick disconnect and alignment features on beam-line components
Install radiation resistant devices
Assemble parts outside of the area
Identify lower dose rate areas
Use mirrors and video cameras

Question: True or False? - ALARA applies to anywhere it is reasonably achievable to reduce radiation dose.

Answer: True.

Question: How is ALARA achieved?

Answer: ALARA is applied most effectively at the design stage. It is accomplished through planning, job proficiency, shielding, and ALARA committee review and past experiences of staff and Users

Example: During the design and construction stages of NSRL, a movable shield was designed and installed to cover the beam dump in the target room (downstream beam dump). The shield is in place when beam is off and personnel access to the target room is permitted. The beam dump would be an area of relatively higher dose rate.

C-AD ADMINISTRATIVE CONTROL LEVELS (ACL)

Administrative Control Levels (ACLs) are an integral part of the dose reduction scheme at BNL and the C-A Department. These administrative levels are LESS than the dose limits set by DOE and Federal Regulations. The administrative levels help assure that we do not violate DOE limits.

C-AD Administrative Control Levels for Radiation Workers (RW-1 Trained individuals):

Period	Maximum Individual Dose ACL (mrem)	Individual Dose ACL with Line Authority Approvals (mrem)	
Calendar Year	1000	1000 to 1250	(C-AD Chair Approval)
		1250 to 2000	(Lab Director Approval)
Daily	100	100 to 200	(Approval will be on RWP)

C-AD Administrative Control Levels for Visitors, Untrained Individuals and Minors:

Untrained Individuals, Visitors

25 mrem per year

A limit of 50 mrem per year is allowed with written permission from the C-AD Associate Chair for ESHQ and concurrence from the BNL Radiological Control Division.

During a high-intensity proton run (Bldg 912 slow extraction beam (SEB) line) C-AD management DOES NOT ALLOW untrained persons into the experimental areas since exceeding the 25-mrem limit is possible in one day.

Minors

25 mrem per year

Minor (< 18 years) dose limit is 25 mrem per year and parental consent is required. Minors are not allowed to ***work*** in radiological areas but are allowed to visit or tour radiological areas.

Pregnancy

After a female Radiation Worker voluntarily notifies C-AD management in writing that she is pregnant, she is considered a "declared pregnant worker" for the purpose of fetal and embryo radiation protection. The dose to the fetus during the gestation period is to be no greater than 350 mrem at a rate no greater than 40 mrem per month. **Given that there is marginal sensitivity to detect low-level neutron dose (with the TLD), Experiment Spokespersons shall not employ declared pregnant workers around beam lines during high-intensity proton operations.** After a person voluntarily notifies C-AD management that she is pregnant, **she must follow-up and notify management in writing when she is no longer pregnant.**

RADIOLOGICAL WORK PERMIT (RWP)

All personnel entering any posted Radiation Area at the C-AD complex must log into and follow the requirements of the C-AD Radiological Work Permit (RWP) for the area. Persons must read and sign that they are aware of the RWP requirements. RWPs provide a mechanism to document the work review process involving radiation hazards and relate worker exposure to specific tasks.

At this time, most of AGS Bldg 912 is a posted Radiation Area and an RWP is required for entry. Primary areas within Bldg 912 may be posted "HIGH" Radiation Area. An additional RWP may be required for these High Radiation Areas.

The NSRL target room and support building are not Radiation Areas and an RWP is not required at this time. However, a RWP may be required for work with dispersible radioactivity (e.g., irradiated cell cultures, radio-labeled cell cultures).

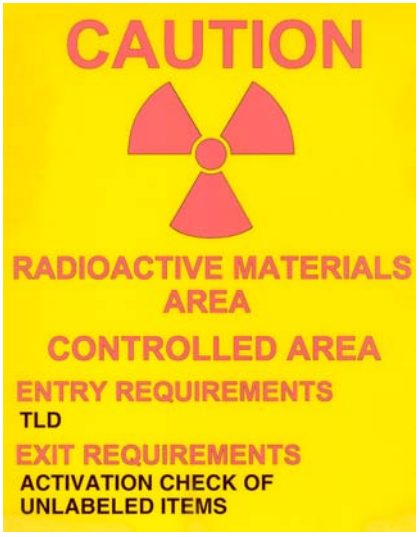
With beam off, the NSRL target room is a posted Controlled Area with TLD required for entry.

RADIOACTIVE MATERIAL AREAS

"ACTIVATION CHECK REQUIRED"

The following posting means you **must not** remove items from the area without having the items checked for activation (radiation). The NSRL target room and all of AGS Bldg 912 are usually posted this way. Contact the C-AD Health Physics Office to get a Radiological Control Technician (RCT) to perform the activation check. (There is usually a RCT already at the facility during running periods.) Users are not qualified to perform activation checks. Activated material must be properly checked, and tagged as required. Note: Performing an "activation" check is different than checking yourself or material for "contamination".

Note Exit Requirements: **"Activation Check "**



Only you can prevent unlabeled radioactive materials from leaving the primary areas. Many small activated parts may be inside primary areas and they will not bear any labels, even though the original assembled item may have a label. Unless you follow the rules, unlabeled activated materials could find their way into offices, common experimental areas or waste streams. If you did not bring an item into a Radioactive Material Area and you want to bring it out, you must have it checked for activation.

NOTE: The intent here is that any item that is possibly activated material must be checked. Generally, no item may be released from areas posted "Activation Check" without a Radiological Control Technician (RCT) first checking the item for radioactivity. However, non-activated items that you bring into an area posted "Activation Check" may be removed without an activation check if you know that the item could not have been exposed to beam or have become activated in any other way. If you did not bring the item into the area, however, and you want to bring it out, then you must have it checked for activation. If ever in doubt, have the material checked.

Targets, target holders, specimen holders, or any other objects that are exposed to primary beam may become highly radioactive and may have to be handled with special care in order to avoid excessive and unnecessary exposure.

Question: What does the posting "activation check required" mean?

Answer: You must have a Radiological Control Technician (RCT) check each item being removed from the area for "activation." Do not confuse this with checking for "contamination" which means each person and all items must be checked ("frisked") for loose radioactive material ("contamination").

Some shield blocks on the experimental floor of Bldg 912 are activated; that is, they have been made radioactive by interaction with the beam. These blocks may be marked with radiation symbols and the word "RADIOACTIVE." ALARA dictates that personnel are aware of ambient radiation levels.

Labels For Shielding

Large concrete and steel blocks: colored radiation symbols with the word "RADIOACTIVE" are painted on blocks and plates to indicate the maximum level of radiation 12 inches (30 cm) from any surface:

Green	< 5 mrem/h
Yellow	5 to 100 mrem/h
Red	>100 mrem/h

Lead bricks, small concrete and steel blocks: the ends of these items are painted with the appropriate color.

RADIATION SOURCES

Shielded container:

Beta, gamma and neutron sources produce radiation levels that may travel many feet in air. The radiation level drops rapidly as the inverse square of distance from the source. This is because most sources are point-like objects. Federal rules define sealed sources as any radioactive item manufactured for the sole purpose of using the emitted radiation. A common example of a sealed source is an instrument calibration source. If you are not sure about the definition of a sealed source, then contact the C-AD Health Physics Office (x4660) in order to make a determination regarding the rules.

When not in use, sources should be stored in shielded containers. Many experimental areas have source boxes like the one shown above. If you are using a source in your work, then the following rules apply, even if you obtained the source from another BNL Department or Division.

- Contact the C-AD Sealed Source Custodian (x5636).
- Have all sources inventoried and leak-checked every six months by the C-AD Health Physics Office (x4660).
- Notify BNL's Isotopes and Special Materials Group prior to shipping a source to or from BNL. Contact I&SM Group at 631-344-4051.
- Complete the ***Sealed Radiation Source Inventory Form*** and keep it with the source.
- The Health Physics Office must be contacted if sources are to be relocated.

If you are responsible for a sealed source, then DOE Orders require than you keep track of it in a way that can be audited by the Federal government.

RADIATION SURVEYS AND CHIPMUNKS

Radiation surveys of experimental areas are conducted by RCTs. During shutdowns, surveys are done initially, and whenever required by an RWP. Records of the surveys are maintained by the C-AD Health Physics Office. During a running period, continuous area monitoring is performed by instruments called Chipmunks, which alarm in the C-AD Main Control Room.

Radiation Monitors (Chipmunks)

The Chipmunk is set up like a traffic light with red, yellow and green indicators. A chipmunk will display a red blinking light for radiation levels greater than 20 mrem/hr, a yellow blinking light for levels greater than 2 1/2 mrem/hr, and a green blinking light when radiation levels are at ambient conditions or less than 2 1/2 mrem/hr (numbers are approximate).

If you see a chipmunk blinking red or yellow, take note of the chipmunk location number, notify your collaborators to leave the immediate area, leave the area and call the MCR (x4662) for further instruction.

Chipmunk readings are also recorded continuously and maintained in a database for later retrieval and review. Chipmunks are capable of alarming locally and are stationed at fixed locations in order to monitor high occupancy areas and other areas of interest. Retrospective exposure rates for any area of interest can be determined by the staff at the C-AD HP Office.

There are approximately 100 chipmunk monitoring devices in use at this time at the C-AD complex. They have pre-designated alarm levels established by the Radiation Safety Committee. Main Control Room Operators are trained to respond to alarms and investigate the cause, even if it means interrupting the physics program.

ABNORMAL RADIATION LEVEL

IF you encounter either of the following conditions:

- radiation levels not anticipated on your RWP
- self-reading dosimeter (SRD)* is alarming or the chirp rate increases unexpectedly
- unexpected high or alarming chipmunk

THEN:

- stop work and place work area in a safe condition
- notify others in the work area
- immediately exit the area
- notify a C-AD Radiological Control Technician and your supervisor (Liaison Physicist or Experiment Spokesperson) as soon as possible - - your TLD badge may need to be read-out immediately

Also contact MCR for alarming chipmunk.

* A digital alarming SRD is required for entry into C-AD High Radiation Areas

RADIATION SAFETY SERVICES

To contact the C-AD Health Physics (HP) Office:

Phone x 4660

The BNL Radiological Controls Division (RCD) provides the C-A Department with services that encompass several operational aspects of safety including radiation safety. They provide dose records and radiation surveys, HP coverage for high-dose jobs, and review of RWPs for ALARA. They also assist in re-setting secondary beam lines, and assist in interpreting abnormal radiation levels.

During running periods, HP coverage is provided on all shifts. During shutdown, services are provided from 8:30 a.m. to 4:30 p.m., Monday through Friday. Assistance is obtained by contacting the HP Office (x4660), or by contacting the C-AD MCR (x4662) and asking for assistance.

Special shifts for RCTs may be pre-assigned allowing for specific round-the-clock coverage when needed. Make arrangements in advance.

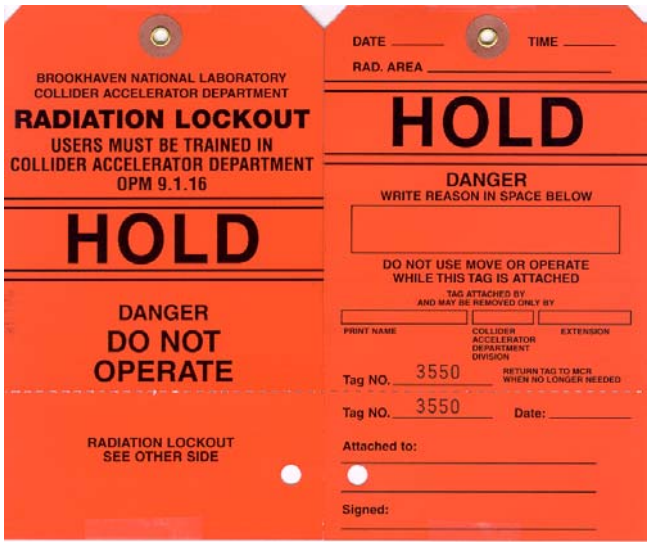
LOCK OUT / TAG OUT
(LOTO)

Lockout/Tagout (LOTO) is used at the Laboratory for personnel safety from energy sources. It is recognized by the presence of a red tag or a lock, and it requires that you obey specific OSHA requirements. In some cases, the equipment cannot be locked and only the red tag is used. In most cases, however, LOTO boots or other commercially available locking devices can be added to the device to enable complete LOTO. If you have questions regarding LOTO in your experimental area, contact your Liaison Physicist.

To prevent accidental radiation exposure, electrical shock or other hazards from different sources of energy, the LOTO shall only be removed by the individual who attached it. Under rare circumstances, however, when the individual who attached the LOTO is not available, the LOTO can be removed by a committee of three other employees provided a specific C-AD procedure for this is followed.

All personnel who must work on electrical circuits that are powered and are controlled by circuit breakers, disconnect switches and/or fuses, must LOTO the circuits. OSHA, NFPA, BNL and C-AD require that all workers performing LOTO be specifically trained and qualified for the task. If you or your co-workers are required to perform LOTO, contact your Liaison Physicist or Experiment Spokesperson. This User training does not allow you to place or remove locks or tags.

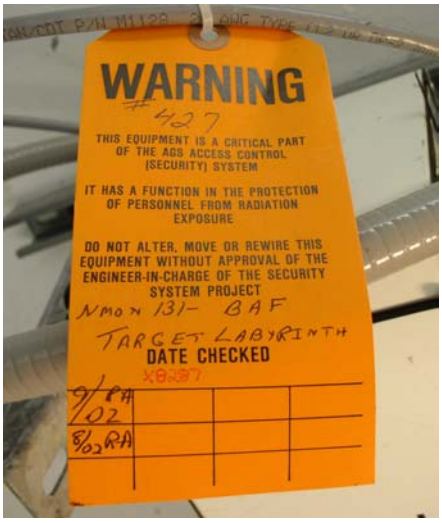
RADIATION SAFETY LOCK OUT / TAG OUT (RS LOTO)



Liaison Physicists, Liaison Engineers, Access Controls Group staff, Operations Coordinators (OC), members of the Radiation Safety Committee, and certain other personnel perform RS LOTO. They must follow a specific procedure in order to lock out and tag out equipment or beam lines for radiation protection. Equipment or beam lines are generally locked out during barrier modifications or barrier removals, or whenever the Access Control System alone does not provide the required protection. **DO NOT** alter or otherwise tamper with equipment that bears the RS LOTO tag. This User training does not allow you to place or remove locks or tags.

ORANGE TAGS

The devices sensed by the Access Control System must remain correctly connected. In order to help ensure that personnel do not disconnect or alter these devices without following the approved procedure, the Access Controls Group will identify such devices with an **orange warning tag**. In the experimental areas, these tags alert personnel that the device is critical to safety and the operation of the Access Control System. **Do not move** these devices since relocation will compromise their effectiveness. Contact the Main Control Room if these devices are inhibiting your work.



Program disruption and/or electrical shock may occur by overlooking an orange warning tag.

Tags and signs are often placed only on the front of equipment. Look at the front of equipment.

LASER SAFETY

Use of Class II and IIIa lasers require a permit.

Use of higher class lasers, Classes IIIb and IV, requires additional Laboratory training as well as a Laboratory Standard Operating Procedure (SOP).

Make sure you are aware of the safety requirements established for lasers in your area.

If you have questions regarding lasers, you may contact the C-AD Laser Coordinator, Asher Etkin, on x4006, Bldg 911.

COMPRESSED GAS SAFETY

GENERAL RULES FOR CYLINDER HANDLING

NOTE: Additional BNL Training is required if you will be handling compressed gas cylinders

It is preferred that you have BNL personnel handle compressed gas cylinders for you. This can be arranged through your Liaison Physicist or Liaison Engineer. If you must handle compressed gas cylinders, keep the following precautions in mind: (you would also be required to take BNL's Compressed Gas Safety Training)

- Do not drop cylinders or permit them to violently strike each other
- Do not roll cylinders in a horizontal position
- Do not drag cylinders
- Do not handle cylinders with oily hands or oily gloves (This is especially important when handling oxygen and other oxidizers)
- If hoisting is necessary, use a suitable cradle or platform
- Do not lift a cylinder by its cap
- Keep cylinder caps on the cylinder whenever they are not in use
- Transport cylinders using a cart or hand truck designed for that purpose
- Whenever placing a cylinder in service, check the hydrostatic test date (5 year max between dates)
- Tear off the bottom of the Cylinder Status Tag and write the name of the assigned user on the tag indicating that the cylinder is in use

DELIVERIES TO C-AD FACILITIES

Under the Price-Anderson Amendments Act (PAAA), we are required by Federal law to obey all radiation safety rules or face stiff penalties if we do not. All persons, including delivery people, who enter areas controlled for radiation protection must be properly trained, or be escorted by a trained radiation worker, and be wearing any required dosimetry (TLD for example). Escorting must be approved according to C-AD procedure. To ensure that delivery people do not inappropriately enter posted areas, all deliveries to the C-AD complex are to be made to **Building 100** (for normal business hours).

Arrangements can be made with the Main Control Room (x4662) for off-hour deliveries. Make arrangements in advance. When the delivery is made to the MCR, personnel there will then contact the addressee.

Under no circumstances are deliveries to be made to other buildings in the C-AD complex without approval of the C-AD ESH&Q Division Head (x5272, pager 4820) or designee.

When placing an order, inform vendors to address the package to **Building 100**, and also inform them to include your name on the package so that personnel receiving the package at BNL have a way to contact you. Packages arriving without a name will likely be sent back.

SHIPPING OFF-SITE

IF YOU ARE SHIPPING ITEMS OFF SITE , ASK YOURSELF THESE QUESTIONS

IS THE ITEM RADIOACTIVE ?
To check if items are radioactive contact Health Physics x 4660. Radioactive Materials must be shipped through the BNL *Isotope and Special Materials Group* x4051.

DOES THE ITEM CONTAIN HAZARDOUS MATERIAL?
Contact C-AD Environmental Coordinator x7520.

DOES THE ITEM CONTAIN BIOLOGICAL MATERIALS?
Contact your Experimental Spokesperson (Marcelo Vazquez x3443, Betsy Sutherland x3380)

Still unsure of how to ship material on or off site?

Then contact your Liaison Physicist (Adam Rusek) x 5830

Individuals transporting biological materials to and from the BNL site must comply with protocols set forth by the BNL Medical and Biology Departments. All transfer of biological materials to and from the C-AD experimental facilities must use Laboratory Animal Care Vehicles or Government Vehicles.

HARDHAT POLICY

You are required to wear a hardhat:

- At all times at construction sites
- When people are working overhead
- When overhead cranes are operating above you

FIRE OR OTHER EMERGENCY

In your work area, make a mental note of the following:

Exits
Fire Alarm Pull Boxes
Crash buttons
Crash cords
Inter-phones, house-phones or PA systems
Emergency exhaust, if any
Telephones

Question: You need immediate help in an emergency such as an illness or injury; What do you do?

Answer: Pull a fire alarm box (if there is one in the area) and call x2222 or x911. This is the preferred method for contacting the emergency response team.

Fire Alarm Pull Box

Question: There is a fire in your area. What do you do?

Answer: Warn others and evacuate the building; pull a fire alarm pull box.

In any emergency, (for example if there is a medical emergency involving an injury or an illness such as a heart attack or other illness or injury for which immediate medical attention is wanted) you may (and are encouraged to) pull a fire alarm box; it does not have to be a fire. Also call 911 or 2222. From a cell phone dial 344-2222 (631 area code). Fire alarm boxes are located

throughout the complex. This is the best method to simultaneously alert the C-AD Main Control Room (MCR) and the BNL Fire/Rescue Group. Pulling a fire alarm box and telephoning 911 or 2222 brings the Fire/Rescue Group to your specific alarm-box location within minutes, and appropriate additional personnel can be summoned quickly.

Unless an injury is very minor:

Never transport the injured person to the Clinic yourself, wait for the Fire Department to arrive with the EMT and ambulance. Make sure you pull the Fire Alarm box to immediately let Fire/Rescue know of the location of the problem. Follow up immediately with a call to 2222 or 911 or on a cell 344-2222 to let F/R know it is an injury so the EMT/ambulance are dispatched to the scene (they usually don't send the ambulance for a fire only).

If you transport the person yourself, time may be wasted in having the ambulance track you down. In addition, you may be stuck with an injured person who passes out or stops breathing, etc., on the way to the Clinic or you could be nervous and have an accident on the way to the Clinic.

Primary areas and target caves are of limited space. If fire should break out, then smoke could quickly impair visibility, and asphyxiation from smoke is a possibility. If fire breaks out, then get out immediately. Emergency exit signs will point you to the nearest exit.

Once outside a smoky area, report to the Local Emergency Coordinator (LEC) or the Department Emergency Coordinator (DEC) if they are present. They will be wearing baseball-like caps marked DEC or LEC. Do not chat with the Fire Captain or other emergency response personnel in the area. Obey the directions of the Fire Captain, DEC or LEC.

The fire safety program at BNL emphasizes prevention through the design of buildings and automatic protection. If you suspect a fire, pull a fire alarm box and telephone 2222 or 911. Warn everyone in the area and evacuate as required. If you think you can combat the fire without putting yourself in danger, a fire extinguisher may be effective. **Never let the fire get between you and your escape route**. Use a fire extinguisher only if you are trained and it can be done safely. Only use a fire extinguisher if you're confident in your ability to put out the fire safely. Determine what is burning and select the appropriate fire extinguisher. Fire extinguishers are classified according to their ability to handle specific types and sizes of fires. If you have any doubts, let firefighters handle the situation.

FLAMMABLE GAS/LIQUID SAFETY

Many experiments involve the use of flammable gases and flammable liquids. Gas distribution and gas mixing systems must meet the requirements of BNL Environmental, Safety and Health (ES&H) Standards. These standards are issued to Liaison Physicists, Liaison Engineers and Experiment Spokespersons.

COMBUSTIBLE MATERIALS

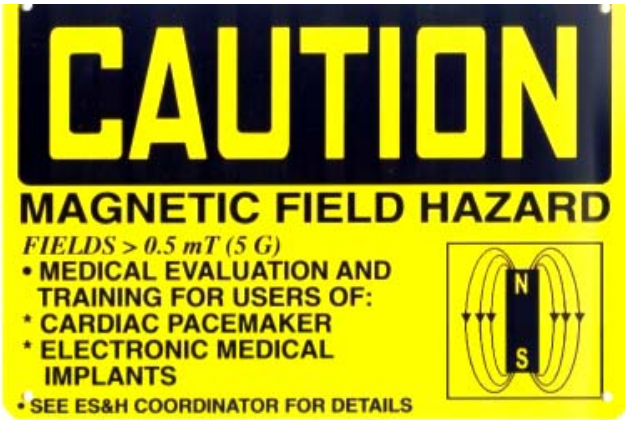
Users occasionally collect wood, plastic, paper or other combustible material in significant quantities near experiments. We must strive to remove these materials where possible, and we should strive to meet the life-safety code by not blocking exits or aisle ways with these materials. Storage areas are assigned to experiments for the purpose of storing experimental equipment, cables, packing materials and other combustible items. Consult your Liaison Physicist.

HANDLING LEAD (Pb)

You may encounter Pb in primary areas. Please be aware that handling Pb may be hazardous and you are required to have additional laboratory training and use personnel protective equipment.

Pb may be found in brick, sheet, or cast forms, or as wool which is used in Pb blankets. In most applications, the bare metal should be covered or painted if practicable. You need to wear safety shoes and gloves when handling Pb bricks or sheets of Pb. You are not allowed to shape, drill, or otherwise work with Pb in any way that causes it to become dispersible. If you require that lead be shaped or cut, then contact your Liaison Physicist or Liaison Engineer.

MAGNETIC FIELD SAFETY



Use extreme caution with iron and steel objects when working around magnets, especially those with large gaps. Follow any magnetic safety plans that are specific to your experiment. Be sure you do not inadvertently energize a magnet before the area is clear. Remember the field may be effective at a surprisingly large distance. Aside from possibly pulling ferrous objects from your grasp, your credit cards may be damaged if you get too close.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommended exposure limits for static magnetic fields. Exposure of the whole body should not be allowed in fields greater than 600 gauss on a daily basis (8-hour time-weighted average), and extremities like your arms and legs should be exposed to less than 6000 gauss (8-hour time-weighted average). Cardiac pacemaker wearers (or users of other medical electronic devices) should not be exposed to fields greater than 5 gauss. DOE has adopted the ACGIH recommendations as its own standards and has indicated this through DOE Orders. Thus, you should limit your own personal exposure according to these rules.

CHEMICAL SAFETY

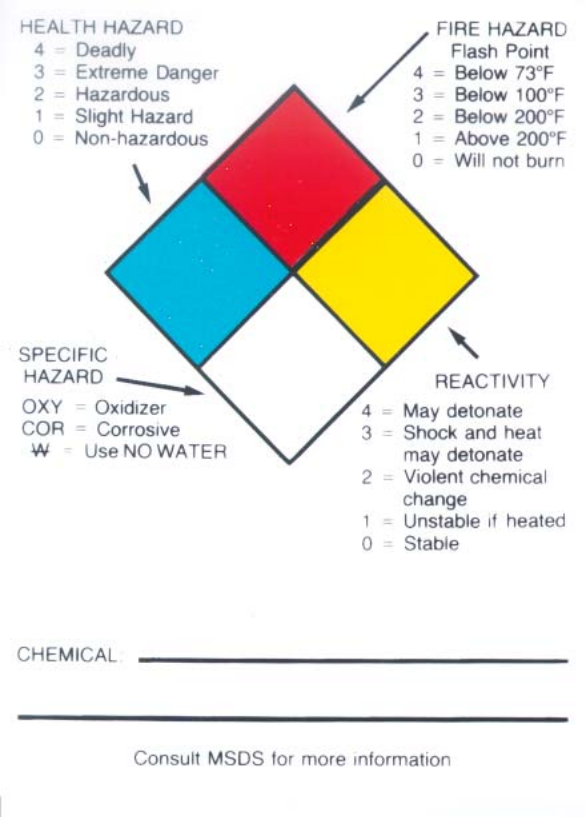
For your safety, purchased chemicals are inventoried by the Laboratory prior to delivery for end use. All chemicals, including anesthetics, to be used in your experiments must be clearly indicated in your experimental proposals . If you bring un-inventoried or unapproved chemicals on site contact the ES&H Coordinator (x 4006) to have these chemicals inventoried and bar coded prior to use.

The use and inventory of **Controlled Substances** at the laboratory is strictly regulated. Contact Experiment Spokesperson Marcelo Vazquez x 3443 to ascertain the required documents and procedures prior to using and bringing any controlled substance on to the Laboratory site.

INFORMATION ON HAZARDS
YOUR RIGHT TO KNOW

You have the right to know about potential health and safety hazards in your workplace. Whenever the potential for exposure to hazardous materials exists, you may be provided with specific safety and health information by the ES&H Coordinator. Contact the ES&H Coordinator at x4006, pager 453-5940. The ES&H Coordinator can provide you with information on the Laboratory's policy on hazardous information, how to obtain Material Safety Data Sheets (MSDS) and how to interpret them. Examples of information that can be found on an MSDS is the name of the chemical, manufacturer, hazardous ingredients, physical characteristics, fire and explosion hazard data, reactivity data, health hazard data, precautions for safe handling and safety control measures.

National Fire Protection Association (NFPA) diamonds appear on various materials, structures and containers indicating the hazard type and degree.

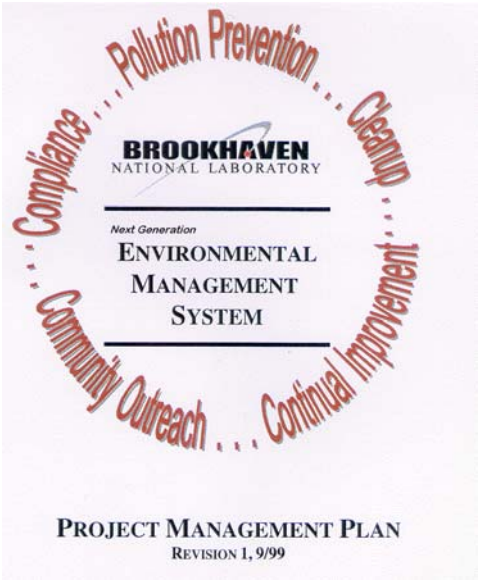


The ES&H Coordinator can also provide information on how to select and use protective equipment, and explain the labeling system used on chemical containers.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Department safety policy states that each workplace should be created and maintained in a manner that minimizes safety and health problems. For some jobs, eliminating the hazard is not always practical. In some cases protective clothing and protective equipment is required for safety. Plan your work in advance. Consider whether PPE may be needed. For approvals and review of the use of PPE contact the C-AD ES&H Coordinator (x4006, pager 453-5940).

WASTE DISPOSAL



CAUTION:

Improper disposal of radioactive or hazardous waste may result in fines, criminal prosecution, and facility shutdown. Contact the C-AD Environmental Coordinator (x7520) well in advance of establishing any airborne, liquid or solid radioactive- or hazardous-waste-stream. The C-AD Environmental Coordinator is familiar with rules, permits, authorizations and analysis requirements necessary for proper disposal.

Removing waste from the Laboratory is complex and costly. Your cooperation is necessary in order to control waste according to Federal, State, and Suffolk County regulations. Additionally, the regulations of States where waste from C-AD is ultimately disposed of must also be followed.

Some general rules and guidance:

- Do not place clean materials in radioactive waste bins
- Substitute reusable materials where possible
- Use minimum quantities of materials
- Segregate wastes
- Do not leave unnecessary items in primary areas

DO NOT leave medical or biological waste items at the C-AD experimental facility. All such waste is to be returned to the BNL Medical or Biology Department.

Each person is responsible to ensure that they handle, accumulate or dispose of waste using adequate controls and documentation. Your Liaison Physicist can explain those controls, or you may contact the C-AD Environmental Coordinator (x7520) or Environmental Compliance Representative (x2905) for details.

SPILLS

The C-A Department is required to report spills internally, externally (to external organizations such as NY State agencies, DOE) or BOTH. C-AD must report ***quickly*** to external agencies on spills that impact the environment. Even minor events such as spilling any amount of oil in an outdoor area to soil or a waterway require reporting. If you spill any hazardous or industrial material outdoors to soil or a waterway, or anywhere inside and the spill is beyond your control, call x2222 or 911 to report the spill. Then call the C-AD Main Control Room (x4662), the C-AD ESHQ Division Head (x5272) or the C-AD Environmental Coordinator (x7520). When reporting, give your name and information on spill location, type of material and approximate amount (as best as you can). **Do not leave a message on an answering machine as notification.**

The rules are such that we must *consider* reporting spills of any type or size.

When must a spill be reported by calling 911 or x2222?

- Unexpected releases of oil, hazardous substances or radioactive materials known or suspected to have impacted the environment (including spill to the soil or a waterway, regardless of size of spill)
- Any hazardous material spill where your actions would result in exposures to chemicals above established safety limits
- Spills where you possess neither appropriate equipment nor training to mitigate the incident
- Airborne releases of hazardous materials or spills that are likely to result in an uncontrolled release of the hazardous material

When do I not have to call in a spill to 911 or x2222?

All of these must be met:

- The spill is onto an impermeable surface
- The material spilled is not highly toxic or highly volatile
- The person responding to the spill has appropriate training and materials to clean up the spill
- For petroleum based products, the volume of the spill is less than 5 gallons
- The spill is cleaned up immediately

RADIATION HAZARDS

- PRIMARY BEAM: in-beam dose rates up to 10^{14} mrem/h from hadrons.
- SECONDARY BEAM: in-beam dose rates up to 10^{11} mrem/h from hadrons, and leptons.
- FAULTS: radiation penetrating through shielding from unplanned beam losses may lead to doses of several tens of mrem from neutron and gamma radiation near shielding or fences. Faults may last up to a period of about nine seconds before machines are interlocked off.
- NORMAL OPERATIONS: about 1 to 2 mrem/h or less in continuously occupied areas from neutron, and gamma radiation that penetrates the shielding.
- RESIDUAL RADIATION: some primary beam components are up to 10,000 mrem/h (gamma).

The principal radiation exposure associated with the C-AD primary areas derives from the high-level residual-radiation. Radiobiology experimental primary areas are selected areas where little activation has occurred.

Direct exposure to the beam is not possible if areas are entered in the correct way. However, exposure to radiation from unplanned beam losses in areas adjacent to primary areas is possible. This may result from brief excursions lasting a few seconds such as during a beam crash due to loss of a steering magnet power supply.

RESIDUAL LEVELS IN PRIMARY EXPERIMENTAL AREAS WHEN BEAM IS OFF		
AREA	LOCATION	RESIDUAL LEVEL, mrem/h
SEB 'A' Primary Line	Radiobiology Station	0.5
NSRL	Building 958 Target Area	0.5

The dose rates shown in the above table are approximate and are based on radiation surveys taken shortly after operations.

SAFETY ATTITUDE

We know from national accident statistics that 10% of accidents result from unsafe conditions and that 90% result from unsafe acts. At C-AD, our experience has also been that accidents and reportable occurrences are largely due to unsafe acts. We can and will continue to engineer hazards out of the C-AD facilities. However, you are the person most responsible for your safety, and your attitude with regard to following the rules will always have the greatest impact on safety at C-AD. Rules shall be followed even when you are short-handed. Do not violate safety rules to get the job done.

Question: Who is the person most responsible for your safety?

Answer: You are the person most responsible for your safety. Use common sense. Never assume you know all the hazards. When in doubt, consult an expert. Your Liaison Physicist can assist you with safety concerns.

We strive to maintain an excellent safety record in such a complex environment without undue inconvenience to the Users. With your help, over the last few years we have significantly reduced fire losses, radiation dose, reportable occurrences, environmental releases and injuries. We can assure the continuity of this safety record only by having the active cooperation of each individual who has access to the primary and secondary experimental areas. Each of you must familiarize yourselves with applicable safety regulations and experiment procedures.

In the recent past in New Jersey, an Exxon worker did not turn off an ignition source, which was the truck he drove to a gas storage site, he did not wear his protective clothing to perform the job, and he did not follow a procedure that minimized gas leakage when he opened valves. These were all small failures that added up to a tragedy. A film of this incident is available for viewing (~1 hour long) from the BNL Safety and Health Services Division. See the C-AD Training Coordinator if you want to view this film. Likewise, simple failures have added up to major disruptions at BNL, such as not installing groundwater wells south of the HFBR or not installing an interlock on the C-line diffuser at AGS. The risk of losing 500 jobs due to a forced shutdown is very real at BNL since our work is radiological in nature. We do not have to ignite a few million gallons of gasoline in order to have upheaval and misfortune.
Many "errors" in series must usually occur to cause an accident. For a single accident there may be many causes and sub-causes, and certain combinations of these give rise to accidents. From a simple viewpoint, the causes can be grouped into the following two categories:

a) Behavioral - This category includes factors pertaining to the worker, such as improper attitude like the Exxon worker, or lack of knowledge, lack of skills and inadequate physical and mental condition. In the case of the Exxon worker, his attitude was based on years of experience in which nothing ever went wrong for him whenever he took a short cut.

b) Environmental - This category includes improper protection from hazardous work elements and degradation of equipment through use and unsafe procedures and inadequate maintenance. Major accidents are rarely, if ever, the result of a single cause or act. You can view an accident as toppling dominoes. The accident will occur if the sequence of events lets all the dominoes topple to the last. If one or more of the dominoes is removed, then the last domino toppling, which is the accident, probably won't occur.

After an accident, most people tend to look for "things" to blame, because it's easier than looking for "root causes," such as those listed below. Consider the underlying accident causes described below. Have you been guilty of any of these attitudes or behaviors? If so, you may not have been injured, but next time you may not be so lucky.

Taking Shortcuts: Every day we make decisions we hope will make the job faster and more efficient. But do these time savers ever risk your own safety, or that of coworkers?

Being Over Confident: Confidence is a good thing. Overconfidence is *too much* of a good thing. "It'll never happen to me" is an attitude that can lead to improper use of procedures, tools, or methods in your work.

Starting a Task with Incomplete Instructions: To do the job safely and correctly the first time you need complete information. Have you ever been sent to do a job, having been given only a part of the job's instructions? Don't be shy about asking for explanations about work procedures and safety precautions. It isn't dumb to ask questions; it's dumb not to.

Poor Housekeeping: When managers, supervisors or safety professionals walk through your work site, housekeeping is almost always an accurate indicator of your attitude about safety. Poor housekeeping creates hazards of all types.

Ignoring Safety Procedures: Purposely failing to observe safety procedures can endanger you and your coworkers and cost you your job.

Mental Distractions from Work: Having a bad day at home and worrying about it at work is a hazardous combination, and visa versa. Dropping your 'mental' guard can pull your focus away from performing any task safely including changing the gas bottle on your barbecue. You can also be distracted when you're busy at work and a friend comes by to talk while you are trying to do a hazardous job. Don't become a statistic because you took your eyes off the job at hand "just for a minute."

Failure to Pre-Plan the Work: Job Hazard Analysis and Enhanced Work Permits are an effective way to figure out the smartest ways to work safely and effectively. Being hasty in starting a task or not thinking through the process can put you in harms way. Instead, Plan Your Work and then Work Your Plan.

LIST OF ACRONYMS

AGS	Alternating Gradient Synchrotron
ALARA	As Low As Reasonable Achievable
BAF	Booster Application Facility
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
C-AD	Collider-Accelerator Department
CAS	Collider Accelerator Support Group
DEC	Department Emergency Coordinator
DOE	United States Department of Energy
ESD	BNL Environmental Services Division
ES&F	C-AD Experimental Support and Facilities Division
ES&H	Environment Safety & Health
FEB	Fast Extracted Beam
HP	Health Physics
I&SM Group	BNL Isotopes & Special Materials Group
LEC	Local Emergency Coordinator
LOTO	Lock Out Tag Out
MCR	Main Control Room
NFPA	National Fire Protection Agency
OC	Operations Coordinator
ODH	Oxygen Deficiency Hazard
OSHA	United States Occupational Safety and Health Administration
PAAA	Price-Anderson Amendments Act
RCD	BNL Radiological Control Division
RCT	Radiological Control Technician
RHIC	Relativistic Heavy Ion Collider
RWP	Radiological Work Permit
SEB	Slow Extracted Beam
SRD	Self-Reading Dosimeter
TLD	Thermo-Luminescent Dosimeter